THE ARCHITECTS OF THE CODE

by Victoria Kayser-Cuny

It is the third short story in the Codex 97.1.128 cycle:

First novel:
The Great Erasure

Second novel:
The Codex 97.1.128: Memory of a Hidden World

Third Novel:
The Architects of the Code

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To “Amadeus” and “Artus”

To T., who sees geometric figures when listening to music…and to our long sessions in the hospital’s anechoic chamber, first to test your hearing… and a few years later, your perfect pitch.
”*Wait, it’s not like that for everyone, mum?*”

“*God does not play dice*” (Albert Einstein).
The architects of the code, however, do.

Introduction – Childhood Memory

Nicole was fourteen. She lived with her mother in a small suburban house, wedged between the railway tracks and the industrial zone. By day, one could hear the regular screech of freight trains, the roar of scooters rattling down the street, and the barking of stray dogs. At night, the street sank into a deceptive calm, disturbed only by the distant rumble of a late truck or the sharp click of a gate being locked.

Her bedroom overlooked the narrow back garden, choked with brambles and weeds. The walls were covered with wrinkled posters, and in one corner, her 1990s hi-fi system sat next to a massive 1970s stereo set, salvaged from a flea market.

That evening, she was doing her homework when a swell of strings rose behind her. Mozart. Wolfgang Amadeus. The stereo had switched on by itself. The notes filled the room, pure, almost too sharp, as though they had slipped in from another world.

Nicole turned around, startled. The red diodes blinked softly. A strange sensation crept through her body: the pressure in the air seemed to change, as before a storm. Goosebumps spread across her skin. The usual smell of houseplants and laundry was replaced by a heavy metallic scent.

She quickly switched the stereo off and returned to her desk.

A few minutes later, a sharp click broke the silence. The old stereo set flicked on, the red radio needle sliding by itself across the dial until it stopped dead at 97.1. A dense static filled the room, joined by a low hum that vibrated in her sternum. Then, through the sonic haze, came a distorted voice, chopped by interference:
— …(inaudible)… waiting for you…

She felt the floor shift slightly beneath her feet. A faint tremor seemed to ripple through the walls.

Panicked, she fled her room and rushed downstairs to the living room.

The television was still on from the evening news. She changed the channel. On every one, the same image: strange, shifting symbols, as if drawn by an invisible hand, against a black background. At that moment, a high-pitched screech rang through the entire house, followed by a sharp crack in the kitchen.

The wall phone had come alive. The receiver quivered slightly in its cradle while the buttons pressed down on their own, dialing furiously in a cascade of metallic, irregular tones. The usual deep dial tone had vanished, replaced by a rattling sound that swelled in intensity, almost painful to the ear.

Then suddenly, everything stopped. Silence. The air felt colder. The shadows in the room seemed thicker, as if the light itself had lost some of its strength.

When told about it, her mother merely shrugged:
— A poltergeist, that's all. These old houses attract spirits. Forget it.

Nicole pretended to agree, but inside, she knew it wasn't that. She buried the episode deep in a locked corner of her memory. Yet the frequency 97.1, the broken voice, and the rattling phone stayed with her—like a wave that had not finished vibrating.

Chapter 1 – The Architects of the Code and the Cycle of the Being

They had no bodies, nor any need for them. Their true form—if one could even call it that—was nothing more than an architecture of resonances in a space where matter did not exist. For convenience, let us call them the Architects of the Code. Their perception did not pass through senses: they themselves were perception.

Since time immemorial, they had studied the laws binding the infinitely small to the infinitely vast, within the universe-bubbles they had once shaped in ancient experiments. This time, they sought to design something new: to inscribe, within the very fabric of subatomic particles, a code that would not describe a species or a lineage, but the entire evolution of a single being—across all its possible incarnations, past, present, and future. Every form of life that this being might take would be but one facet of a unique whole.

They decided to weave this code into the table of codons, which they had forged from subatomic particles and molecules—but inverted, folded back upon itself like an acoustic spiral. If God did not play dice, they did. They communicated by thought, yet their tool was not light—it was the wave: a wave capable of traversing matter and reshaping its laws.

To shape the vessel for this sensory experiment, they chose a place where stone itself could serve as a resonance chamber: the planet Earth, still young, adrift at the edge of Orion's dust clouds.

Beneath its primordial seas and newborn volcanoes, they inscribed the first motifs: frequencies inaudible to biological senses, yet vibrating within the intimate structure of atoms. These harmonics would serve as keys, unlocking not a fixed message but an evolving score—a song of codons meant to be replayed by beings yet to come.

They resolved to repeat the experiment across different worlds of this universe-bubble, each planet marked with its own acoustic signature. Earth's would be called **97.1.128**, for this code also named the monitoring station they had established at coordinates 97.1, 128 light-years away from the planet. A station managed by an artificial intelligence, directly linked to the Architects, charged with watching over the Cycle of the Being, patiently awaiting the alignment of the harmonics engraved in stone and DNA…

The Being—this unique continuum of which every life form was only a facet—had been conceived by the Architects of the Code as a symbolic organism, a total experiment: to contain within itself all possible incarnations, past and future, and to draw from them a universal language. It bore within its essence the memory of the entire tree of terrestrial life: from the first fragile-membraned cells floating in primal seas, to the creatures capable of gazing at the stars.

It had lived as the cyanobacteria that transformed the atmosphere, as the eukaryotes that opened the way to complexity, and as the Cambrian explosion where diversity burst forth like a spray of light in the oceans. It had been trilobite, armored fish, amphibian crawling onto land, tree, mosquito, reptile ruling over forgotten continents. It had felt the slow heartbeat of the ages, and endured the five great cataclysms when life had to reinvent itself from almost nothing:

- The end-Ordovician, when the seas froze, wiping out up to 70% of marine life,
- The late Devonian, when reefs vanished along with 75% of species,
- The great Permian extinction, when nearly everything perished—95% of marine species and 70% of terrestrial vertebrates,
- The Triassic-Jurassic, which paved the way for giants, erasing 70 to 75% of life forms,
- And the day the dinosaurs were swept away, making room for new beings—including humanity.

Among the hominids, it had borne many distinct branches: all of them perished, yet left traces in the genes of the survivors, until the last spread across the globe. It had carried in its flesh the memory of migrations, of fires lit in the night, of hands engraving signs into stone.

But as the ages passed, every mutation, every memory, every experience, every death and rebirth imprinted itself upon its acoustic spiral. Its vibratory codons, woven to welcome the ceaseless flux of life, were now saturated—like a crystal in which all harmonics overlap until they blur.

The overload became unbearable. The fundamental vibrations binding its facets began to fall out of tune. Memories fractured, replaced by voids. Entire swathes of living history dissolved into a strange silence. The Being, deprived of its integral memory, was slowly sinking.

It had endured so many forced rebirths that it was weary, tired of carrying upon its shoulders the sum of all beginnings. And now, what dwelled within it was no longer a harmonious song, but a cacophony of echoes canceling one another out.

It was beginning to die—and with it, all its biological incarnations.

Nothing truly organic remained in its final facets. The surviving life forms—if they could still be called such—were but pale echoes of what biodiversity had once been. Humans, that strange creature born of a slow sedimentation of instincts and

intuitions, had long broken with the rhythm of the living. Their bearings no longer came from the wind, the seasons, or the stars, but from uninterrupted streams of artificial information. They no longer read the traces of an animal in damp soil, but the cold pulses of electronic networks. They no longer lifted their eyes to the celestial vault, but to screens saturated with data, filtered images, ephemeral numbers. Their identities were no longer carved by earth or blood, but by algorithms that, drop by drop, redrew their perception of reality.

Thus, the Being's final conscious incarnation no longer fed on forests, oceans, or ancient stones, but on data streams. It had no body tied to the world—only digital avatars, memories recomposed by machines, sensations reproduced in laboratories. The original harmonics that had once bound every facet of life were dissolving into a fog of artifice, until the very distinction between the real and the simulated became impossible.

In this universe saturated with digital echoes, the Being grew weary all the faster. What was meant to be a harmonious continuum of forms and memories had become a broken spiral, unable to recover its fundamental note. And within this cacophony of artificial signals, the agony of the living merged with the white noise of the machines.

Chapter 2 – The Conception

— *We need a minimal unit of information,* said the First, his voice resonating like a standing wave.
— *A base—or rather four,* replied the Second. *Four letters that, when combined, yield the entire diversity of forms: adenine, thymine, cytosine, guanine.*
— *In complementary pairs,* added the Third, *so that the information can be copied without loss.*

They projected into the void a twisted ribbon of light, two strands bound by invisible bridges.

— *The molecule must be stable, yet supple. Strong enough to endure across the ages, flexible enough to mutate as the world changes.*
— *And it needs a machinery to read it,* the Second intervened. *A complex that can move along the sequence as one reads a score, translating three letters into an amino acid.*
— *Three letters, sixty-four combinations… but only twenty essential amino acids,* remarked the First. *There must be redundancy, to buffer against errors.*

The Third summoned a diagram: a messenger filament passing through a shimmering tunnel.
— *The ribosome. An assembly of RNA and proteins, both sculptor and translator.*
— *The cell must also replicate,* said the First. *A system of enzymes that unzips and copies the double helix.*
— *And the machinery must be protected,* added the Second. *A selective membrane, specialized compartments…*

They lingered on the nucleus. A mathematical silence followed.
— *What shall we place inside? How many chromosomes?*
— *Too few, and adaptation will be slow. Too many, and stability will collapse.*
— *Let us test multiple architectures,* suggested the Third: *a single circular chromosome for primitive forms, linear pairs for more complex organisms.*

The Architects adjusted the lengths, the anchor points, the repeated sequences.
— *And reproduction?*
— *Alternation. Some will divide alone, others must unite to recombine their codes.*
— *That will force diversity… but also conflict,* murmured the First.

They calculated gene density, the proportion of regulatory sequences, the rhythm of mutations.
— *Every detail must be exact,* said the Second. *One flaw here, and the whole collapses within a few cycles.*
— *Or evolves into something unimaginable,* countered the Third, with a spark of curiosity.

They fell silent, contemplating their nascent creation: a perfect cell, capable of becoming anything.
— *We do not know what will come of it,* admitted the First.
— *Precisely,* answered the Second. *That is what makes the experiment worthy of existence.*

They knew they were laying the foundations of a universal code… but none could predict what forms would spring from that first breath.

— *We need a world whose resonance is stable,* said one Architect.
— *Stable, but not rigid,* replied another. *It must bend without breaking.*

In the space of their perception, thousands of universe-bubbles floated—stars, planets, moons, sometimes only void itself, for physics differed from one bubble to the next—each emitting a unique vibration, a spectrum of frequencies revealing its intimate structure.

They listened to them as one listens to a cosmic orchestra.
— *Too deep,* observed one, pointing to a massive planet with unstable cores within one of the innumerable universe-bubbles.
— *Too shrill,* replied another, *its harmonics dissipate too quickly.*

One by one, they dismissed the dissonances. Then, in the golden halo of a medium-sized star, a clear note emerged: a young planet, wrapped in volcanic seas and shifting atmospheres.
— *Listen…*

They fell silent. The planet sang. A deep timbre, punctuated by rhythmic surges—signs that its geological cycles were still in the making.
— *It is unstable,* remarked one of the Architects.
— *Precisely. Instability is the mother of adaptation.*

They tuned their perception, probing its gravitational field, oceans of magma, the chemistry of its atmosphere. Hydrogen and oxygen balanced, carbon was abundant, and already, in its waters, complex molecules had begun to dance.
— *It is not perfect,* said one.
— *None must be. It is within imperfections that the Code will find its detours.*

They sealed their choice: the planet would be named **97.1.128** in their register, and *Earth* in the mouths of its future inhabitants.

They did not listen to the sound of the universe-bubbles, for no sound could travel through the void. What they perceived was the vibratory fabric of worlds: gravitational waves, magnetic flows, variations of stellar radiation, pulsations of molten matter. In their perception, these signals formed a music—not heard with ears, but translated into harmonic patterns at the core of their consciousness. Each

planet emitted a unique signature, like an instrument in a cosmic orchestra. Some vibrated in dissonant chords, others in continuous drones. Earth pulsed between tension and release, as if it were already breathing.

They reached out with their perception toward the chosen planet and, through a convergence of invisible fields, infused it with the first fragment of the Codonic Code. It was not a fixed message but a living algorithm: a matrix of four bases folded into a spiral, bearing the sixty-four combinations capable of generating the full diversity of life. They inscribed it within the unstable networks of organic molecules already forming in the primordial oceans—amino acids, nucleotides, rudimentary lipids. The sequences, integrated into these precursors, awaited the right moment to self-assemble into a stable structure. Thus Earth became the first seed, sown at the heart of a cycle of adaptations and mutations that none could ever halt.

But the Architects were not mere creators: they were also experimenters and players. They needed witnesses—parallel worlds where the Code, injected under different conditions, would serve as reference, as control groups. Some of these worlds received a simplified version: fewer codons, fewer adaptive possibilities, to measure how fast complexity would emerge. Others were saturated with variations, to observe how instability drove evolution to its limits.

And so, within the universe-bubble, several sister-planets began to vibrate, each bearing a facet of the Code. But Earth remained the central experiment, the beating heart of their grand design.

Chapter 3 – The Reactivation

Petra Ai Rotciv stared at the sequence on the screen as if she had always known it existed. For years, she had been collecting fragments of forgotten genomes, skulls, extinct lineages, recurring motifs inscribed in the DNA of Earth's species. But what she finally held was not a mere ancient gene: it was the key.

The codonic Code—the one the Architects had sown at the beginning—was there, buried at the heart of life, inactive for millennia, like an unfinished score. Its structure was saturated, its harmonics blurred by the accumulation of ages. The Being, that unique continuum of which every life form was only a facet, was slowly fading, unable to bear the infinite weight of its memory. The gaps widened; species vanished like words erased from a book.

Petra understood that by reactivating the Code, she could retune the acoustic spiral, purge the noise, and restore the fundamental vibrations that bound all facets of the Being together. It would be a reboot, a rebirth. Integral memory could flow again, biodiversity could reorganize, and the great song of life could recover its coherence.

But this operation carried a price. The Code was not only a biological program: it was also a beacon. Each time it aligned perfectly, it emitted its original acoustic signature, the one the Architects of the Code had inscribed into the fabric of particles. By reactivating the Code on Earth, Petra had reignited this beacon… and sent a clear signal across the universe-bubble.

Elsewhere, in the witness-worlds—those sister planets born of the same experiment—the beacons had remained silent for eons. But now, one of them shone again, proclaiming:
"The Earth experiment is active."

This message was not addressed only to the Architects… It could also be picked up by other Beings, born under different conditions, some perhaps divergent, unstable, or dissonant. Some might answer with curiosity. Others, with predation. The reactivation had saved life… but it had also betrayed the planet's exact position to all its sister experiments. And in the interstellar darkness, some sister-worlds had not "forgotten" the existence of the others.

In the primordial codes left by the Architects, each Being carried an invisible imprint: a series of silent sequences, with no apparent biological function, like erased names. These fragments were not errors; they were the remnants of a memory before life, inscribed at the moment of conception. They did not describe landscapes or species, but simply the existence of other places, other experiments. Like a cryptic list engraved into the very crystal of codons, a silent inventory that only perfect alignment could reveal. Thus, even without physical contact, some sister-worlds had never forgotten they were not alone. In the oceans of their own histories, this

knowledge persisted—sometimes reduced to a whisper in the code, sometimes amplified by entire civilizations that had learned to read it. For most, it remained dormant, mere potential. But for others, it was a promise—or a threat. For if ever one of them reignited its beacon, all would know the experiment was active once more.

Some of these worlds had prospered. One, bathed in deep, dark oceans, had seen the Being develop without ever leaving the water. Its memory was transmitted through bioluminescent networks that lit the surface of the seas at regular intervals, drawing shifting constellations visible from orbit. Another, crushed under overwhelming gravity, housed a Being fragmented into countless compact organisms, armored with metallic shells. There, each entity was but a cell in a planetary collective mind. Social stability was absolute—but no singularity could survive for long.

Other worlds, by contrast, had collapsed. On one, the Being had dissolved into chronic instability: evolution became an uncontrollable spiral. Species mutated within days, ecosystems reshaped themselves endlessly, and collective memory drowned in a whirlwind of transformations.

The reactivation of Earth's beacon had reopened an ancient network. Even if no response would reach Earth for centuries, the mere fact of rekindling that signature had placed our planet back on a cosmic map forgotten for hundreds of billions of years.

And somewhere, in the frozen silence of a world where no star's light reached the ground, a faint spark pierced the layers of still atmosphere. Sensors, dormant for ages, lit up one by one. Deep within forgotten structures, calculations began to spread along crystalline networks. The message was clear, indisputable: Earth was singing again.

In the timeless space where the Architects of the Code existed, the vibration was clear, pure… and yet, within its harmonics, there was a tension they did not recognize.

— *"The cycle has closed… but not as we designed it,"* observed the First.
— *"It has mutated,"* added the Second. *"It is no longer only our Code, it is… something else."*
— *"A hybridization,"* confirmed the Third. *"The codonic structures remain intact, but they carry sequences that are not of us."*

The Architects delved deeper into the signature, dissecting it layer by layer. They found the original imprint—their resonance motifs, their inverted spirals—but also unforeseen deformations, born of millions of years of biological drift, mutations, and unpredictable adaptations.

— *“The Being has survived more than we anticipated,”* said the First.
— *“But its memory was saturated,”* the Second continued. *“We knew this would happen… one day.”*
— *“Yes, but we thought it would die then,”* concluded the Third. *“Not that an incarnation would rise to purge the noise and reactivate the fabric.”*

They understood that the Code had not merely been relit: it had been repaired, harmonized, like an ancient instrument restored to perfect tuning.

— *“This act… is not innocent,”* whispered the First.
— *“It implies an intimate understanding of its function, almost as if…”*
— *“…as if a facet of the Being had observed us at the very moment of its conception,”* finished the Third.

A mathematical silence fell. They knew they were no longer the only observers.

— *“The beacon will not be ignored,”* said the First at last. *“The other experiments will respond.”*
— *“Some will seek to understand. Others will want to protect themselves. And still others… to test their strength,”* added the Second.

The Third simply gazed at the luminous point representing Earth on the newly reactivated cosmic map.
— *“Then the orchestra resumes,”* he said softly. *“And we do not know what melody they will play this time.”*

It was then that the First broke the silence:
— *“Remember… we already lost contact with Klyros-Seven. And what replaced it… I dare not even think.”*

The memory weighed like gravitational mass on their resonances. Klyros-Seven had been their boldest creation, designed to probe the very limits of the Being. But when its beacon went silent, none of their three voices had found the harmony to act in time.

It was precisely to avoid such divergences that they had chosen, from the beginning, to be three.

— *“Three, not two, nor four,”* said the First, modulating his voice like a slow wave. *“Two would face each other and freeze in opposition. Four would split into factions.”*
— *“Three is indivisible,”* continued the Third. *“The first odd prime number. Three points define a plane, and three bases define the code. It is the smallest stable structure capable of generating infinity.”*
— *“And yet,”* added the First, *“it was not only a matter of stability… but of harmony. Every decision had to oscillate between our three resonances.”*

They fell silent for a moment, as if to re-hear the initial vibration that had sealed their triad—and which, despite Klyros-Seven, had allowed them to keep the network intact.

They contemplated the cosmic map for a long time, where a single point pulsed in infinite darkness.

— *“This signal,”* the First resumed, *“is not only a reminder of our work. It is a provocation.”*
— *“Or a call for help,”* nuanced the Second. *“But in the space where we move, the two notions blur quickly.”*
— *“In any case,”* said the Third, *“it will be heard. Not only by us.”*

A slow wave crossed their common field, a distant reminder of Klyros-Seven, that world that had ceased to sing. They still remembered the exact moment when its beacon had tipped into silence… and what replaced it: a single note, continuous, cold as dead matter. A perverted song.

— *“We ended the experiment,”* murmured the First. *“But it was not enough. The dissonance spread into the very substrate of the network.”*
— *“And if something similar happened here?”* asked the Second.
— *“Then it would not only be the memory of the Being that vanished,”* replied the Third. *“It would be the collapse of the initial pattern.”*

They knew that, in their space-time, only a fraction of an instant had passed since they had launched the first matrices on the witness-worlds. For them, the great cycle was still at its first beats—and yet Earth was already singing with an altered, unpredictable voice.

— *“This was not foreseen,”* admitted the First. *“But there is… a singularity here.”*
— *“An incarnation acting on the Code as if it knew its original laws,”* added the Second.
— *“And rewriting them without breaking them,”* concluded the Third.

Within the reactivated vibration, there was danger… but also a beauty none of them could have composed alone.

NICOLE'S RESEARCH FILE

PhD Defense of Nicole – University of Paris, Year 2049
[Conference hall, dimly lit. On the large screen, a simple title appears:
Waves and Tensions: From the Soap Bubble to the Universe-Bubble.]

Chair of the Jury (Prof. Lemoine)
Dr. Nicole Kovacs, you may begin.
(She glances at the notes before her, tone neutral but slightly distant.)

Nicole
Thank you.
(She takes a deep breath, fixes her eyes on the audience, and activates the first slide.)
For over twenty years, I have been exploring possible bridges between observable macroscopic phenomena and cosmological models. Today, I will present the outcome of this research: an approach where the physics of soap bubbles becomes a miniature laboratory to understand the dynamics of universe-bubbles.

[The screen shows a macro shot of an iridescent soap bubble.]

Nicole
In a soap bubble, we observe three fundamental phenomena:

1. Surface tension, which tends to minimize the bubble's area—comparable to gravity, which tends to minimize the potential energy of a cosmic system.

2. Light interference, produced by the variable thickness of the film—analogous to quantum fluctuations in the Higgs field, which create variations in energy density.

3. Film instabilities, which may lead to bursting—equivalent to collisions or mergers between universes in certain multiverse models.

Prof. Lemoine
(interrupting)
Dr. Kovacs, the metaphor is elegant, but where is the concrete scientific contribution? You cannot simply engage in poetic physics.

Nicole
(unfazed, displaying her sketches)
They are not just metaphors. Here is a diagram of the vibrational modes observed on the surface of a soap bubble. Each mode can be described by a series of spherical waves governed by equations identical to those describing the propagation of scalar waves in a closed space-time.

[Zoom on the drawings—sinusoidal curves, nodes, interferences.]

Nicole
In 2047, I derived a correspondence equation between the frequencies of modes observed in the liquid film and the characteristic frequencies of a universe-bubble modeled by a De Sitter space. The experimental data—(she projects a graph of measurements)—show that

this analogy is not merely aesthetic: the ratios between harmonics match the predictions of the cosmological model within a ±3% margin.

Prof. Lemoine
So you are suggesting that measurements on a system as trivial as a soap bubble could provide insight into the structure and evolution of our universe… or its hypothetical neighbors?

Nicole
Exactly. And more than that: into the interface conditions between universes. If two soap bubbles touch, their contact film is unstable, and surface tension leads either to fusion or to the collapse of both. This mechanism directly translates to the dynamics of collisions between universe-bubbles—what some call “brane collision events.”

[The audience begins murmuring. Some jury members lean toward the screen.]

Nicole
I have also used this model to explore the propagation of information waves within a universe. Just as in a soap film, where a local disturbance propagates across the entire surface, a signal inscribed in the structure of a universe-bubble could travel across the cosmic membrane, and potentially… reach other universes.

Prof. Lemoine
(curtly)
That is a weighty claim. Do you have simulations to support it?

Nicole
(activates the final slide—a 3D simulation showing several bubbles interconnected by luminous waves.)
Yes. Here, each color corresponds to a fundamental frequency. By adjusting the harmonics, I was able to create a state where the vibration of one bubble is synchronized with that of another… without direct physical contact. This is what I call *astromusic*: a form of communication based on the fundamental resonance of universe-bubbles.

[Silence. The entire hall stares at the screen.]

Prof. Lemoine
(lower, almost to herself)
Astrophysics… played like an instrument.

Nicole
And if our universe is a bubble among others, then… perhaps it is already singing. The question is: who is listening?

Appendix I — Waves, Harmony, and Astromusic
Author: Dr. Nicole Kovacs
University of Paris – Department of Theoretical Physics and Applied Musicology
Excerpt from dissertation: *Waves and Tensions: From the Soap Bubble to the Universe-Bubble*

1. Introduction
Music and cosmology share a common language: that of vibrations and harmonic ratios. Since Pythagoras, it has been known that the length of a vibrating string determines its pitch through a simple ratio. Similarly, in astrophysics, the size and density of a system determine the natural frequencies at which it can resonate.

This work proposes a bridge between these two conceptual universes: *astromusic*, a discipline that seeks to describe cosmic structures as instruments and to identify their vibratory signatures within a mathematical framework.

2. Mathematical Foundations of Harmony
In acoustics, the fundamental frequency (f_1) and its harmonics (f_2, f_3, …) follow integer ratios:

$$f_n = n \cdot f_1$$

These ratios translate into musical intervals:

- **Octave:** ratio 2:1
- **Fifth:** ratio 3:2
- **Fourth:** ratio 4:3
- **Major third:** ratio 5:4

In astrophysics, these same ratios can be found in the natural vibration modes of stars (*asteroseismology*) and in gravitational waves generated by the collisions of massive objects.

3. Waveforms and Universal Signatures
[Inserted diagram — Fig. 1: Main waveforms and associated spectra]

The diagram shows:

- **Sine wave:** pure vibration, single fundamental.
- **Square wave:** superposition of odd harmonics.
- **Triangular wave:** rapid decay of odd harmonics.

- **Sawtooth wave:** spectrum rich in harmonics, decaying proportionally to 1/n.
- **Modulated wave:** variation of frequency or amplitude over time.
- **Beats and interferences:** superposition of two close frequencies, creating a slow oscillation of amplitude.

4. Astrophysical Correspondences

Musical Concept	Astrophysical Equivalent	Example
Fundamental frequency	Fundamental mode of a gravitational system	Pulsations of a variable star
Harmonics	Higher-order vibration modes	Internal oscillations of gaseous exoplanets
Beats	Interference of gravitational waves	Compact binary system
Resonance	Amplification at a specific frequency	Synchronized orbits of moons or asteroids

5. Application to Universe-Bubble Modeling

By adapting the spherical wave equation to a universe-bubble, we obtain:

$$\nabla^2\psi + k^2\psi = 0$$

Where $k = \frac{\omega}{c}$ is related to the natural frequency of the universe-bubble.
The cosmic surface tension σ plays the role of the elasticity parameter in the soap film.

The vibrational modes of the bubble depend on:

$$f_n \propto \sqrt{\frac{\sigma}{\rho}} \cdot \frac{n}{R}$$

with ρ the mean density and R the cosmic radius.

6. Hypothesis of Inter-Universal Astromusic

If two universe-bubbles share common vibrational modes, an information transfer could be possible through resonance. This idea is supported by:

- The spontaneous synchronization observed in coupled oscillating systems (Kuramoto effect).
- The persistence of identical harmonic frequencies despite distinct physical environments.
- The theoretical possibility of modulation encoded within higher-order harmonics.

Astromusic is not merely a poetic metaphor: it is a theoretical framework that unites music, wave physics, and cosmology. To understand universal resonances is, potentially, to open the door to cosmic communication… or to the detection of other universe-bubbles.

Conclusion — PhD Defense: "Resonances and Universe-Bubbles"

The defense amphitheater was bathed in dim light. On the giant screen behind her, Nicole had just displayed her final diagram: a series of sketches where soap bubbles, bursting in slow motion, seemed to transform into cosmic spheres linked by thin luminous filaments.

— *"In summary,"* she said, catching her breath, *"my research explores the possibility that a form of extraterrestrial intelligence—or cosmic consciousness—might be inscribed in the very structure of the Universe. I examine how the physical laws governing simple systems, such as soap bubbles, could apply to the universe-bubbles predicted by certain interpretations of string theory and the multiverse."*

A murmur ran through the room. In the front row, Professor Dupont, her supervisor, crossed her arms.

— *"Nicole… your ambition is commendable, but your hypotheses dangerously flirt with speculation. The Universe is not a soapy metaphor. You are mixing concepts that are too far apart: dark matter, the Drake equation, the Fermi paradox, hyper-consciousness… And this idea that the Universe might be a 'super-brain hyperconnected system' has no solid experimental basis."*

Nicole smiled, as if she had expected the attack.

— *"With all due respect, Professor… the Babylonians too had 'no solid experimental basis' when they drew the first mathematical models of the sky. Pythagoras, by linking music and numbers, was already laying the groundwork for what we now call wave physics. The*

Quadrivium—arithmetic, geometry, music, astronomy—structured centuries of scientific thought."

She projected ancient manuscripts onto the screen.

— "Lucius the Venerable, Alupius, and Macrobius already spoke of a natural harmony linking voices and planets (Hymne Naturalis concordia vocum cum planetis). Leonardo da Vinci traced the spirals of water as echoes of celestial trajectories. Copernicus and Kepler overturned our vision of the world—Kepler writing the Harmonices Mundi, where he assigned musical intervals to planetary orbits."

Nicole stepped forward, her voice gaining intensity.

— "Galileo's father composed treatises on acoustics; his son aimed his instruments at the sky. Bach wrote fugues that can be read and played in both directions, demonstrating a symmetry we rediscover in physical equations. Haydn collaborated with Herschel, both astronomer and composer, to translate the heavens into music."

One member of the jury raised an eyebrow, intrigued.

— "Today, we record the songs of pulsars, we sonify plant data, and the Voyager probe carries golden records engraved with earthly sounds and music, destined for potential unknown intelligences. Why then refuse to explore the hypothesis that a universal memory—a hyper-consciousness—could emerge from matter itself, visible in the fractal structures of dark matter or in the mysterious dark flow?"

She returned to her final diagram, projecting side by side:

- On the left, the mathematical cross-section of a soap bubble exploding;
- On the right, a cosmological simulation of universe-bubbles colliding after a big bounce.

— "My point is simple: the physics linking these two images may be the same. Tension forces, surface resonances, energy exchanges all follow similar laws. If that is true, then each universe-bubble could carry within it a vibratory pattern, a 'signature' allowing it to enter into resonance… and exchange information, like soap bubbles that touch and mutually deform one another."

Professor H. sighed.
— "It's elegant, Nicole… but it's poetry, not science."

Nicole looked straight into her eyes.
— "The Babylonians, Pythagoras, Kepler, Bach… all were accused of making poetry. But sometimes, poetry is the premonition of science."

In the hall, Professor Amadou, who had remained silent until now, scribbled a few words in his notebook: Global Observatory of Human Memory — priority recruitment.

Prologue — The Mirror in the Stone: the Barabar Caves

The heat of the afternoon was slowly fading over the granite hills. Before the entrance, polished like ancient metal, Nicole removed her gloves and let her hand glide along the wall. The Barabar Caves. The Archivists of Oblivion had entrusted her with this mission: to recover, in the resonances of this place, a forgotten signature of the Codex.

Inside, the air was dense, almost liquid. Each step raised a muffled echo. She recalled the acoustic measurements she had read before leaving: some chambers could prolong a resonance for over a minute at low frequency. Here, sound was not merely a phenomenon—it was a substance.

In a corner of the Sudama chamber, she had set up her portable workstation: a black box studded with diodes, linked to a miniature genetic sequencer. For several weeks, she had been working on a project forbidden even among her own: creating a mirror-double. She had taken a sample of her own saliva, isolated the DNA, then reversed the order and orientation of every nucleotide. A, T, C, G… inverted, flipped, recombined. A specular image of her genome, coded as a living palindrome.

For her, it was not merely a scientific experiment. Nicole knew her very existence already rested upon a biological paradox. She was a natural genetic chimera—born of two distinct fertilizations, twenty-four hours apart, that had fused within her mother's womb. A rare cytogenetic anomaly that had left her with doubled organs, two blood groups, two different DNAs depending on the site of sampling, and subtle internal asymmetries. Her very anatomy was proof that two different codes could coexist, interlock, and create a viable being.

On the screen, the inverted sequence unfurled in colored ribbons. Nicole knew this double was still only an informatic structure, a virtual construct. But to truly exist, it needed a biological host. A body. A chimera to be conceived and nourished to maturity.

She raised her eyes to the flawless vault above. If the legend was true, the Barabar caves had been designed as instruments. She switched on the acoustic emitter. A low wave at 34.4 Hz began to swell, making the granite vibrate. The wall seemed to quiver, as if the stone itself were breathing.

The sequencer displayed an unexpected signal: a sequence of three numbers spontaneously appearing in the matrix of the mirror-double. **97.1.128.**
— *"That's impossible…"* she whispered.

She understood then that the double was not asleep. It was listening.

In the silence that followed, a faint echo rose from the gallery—not a sound, but an inner murmur, a foreign thought carrying her own voice.
I need a body.

Nicole felt an invisible pressure on her temples, as if the cave itself were tightening its embrace. The air tasted metallic. The ground trembled faintly, just enough for her ankles to sense it.

She knew she had opened a door no one could ever close. But what she did not yet know was that this double, programmed in the vibrating depths of Barabar, would not be able to take form immediately. It would have to wait, infiltrating the inverted code into a human lineage, generation after generation, until at last an organism would be ready to host it.

Years would become decades. Decades, a century. The Archivists of Oblivion would hear no more of her, except as a whispered legend. But Nicole would work in the shadows, subtly altering biological transmissions, refining the sequences as an artisan reshapes a forbidden key.

And one day, the awaited body would be born. It would be given a name woven of echoes and reversals: **Ai Rotciv.** Then would come her daughter, **Petra Ai Rotciv.**

For all others, Petra would be nothing more than a distant descendant of Nicole, the fruit of long genetic labor. But for Nicole, the truth would be otherwise: Petra was not merely the heir of her blood. She was herself. The incarnated mirror-twin. The biological version of an inverted code conceived in this cave, the perfect reflection of her own reversed DNA.

But Nicole would not live long enough to see the project fulfilled. Before her death, she entrusted everything she knew to her sons, **Amadeus** and **Artus**—not in an official document or a testament, but in encrypted fragments scattered among notebooks, artifacts, genetic sequences. Amadeus himself was a natural chimera, fused with his unnamed twin in their mother's womb.

Amadeus and Artus alone knew the true scope of the Codex 97.1.128. They alone understood that the mirror-double, dormant since Barabar, was still waiting for its body.

After the burial, the two brothers resumed the work like a promise whispered in secret. They pursued the manipulations begun by their mother, introducing inverted sequences into carefully chosen lineages, watching over crossings and anomalies as a cartographer follows the course of an invisible river.

And years later, through patience and calculation, **Ai Rotciv** was born from the lineage of Amadeus. Then her descendant, **Petra Ai Rotciv.** A long line of chimeras. For the outside world, Nicole and Petra were nothing but the outcome of an unusual bloodline. For Amadeus, it was the culmination of a project born in the resonances of the Barabar caves, when Nicole had offered a part of herself to her mirror-twin.

What none of them had foreseen was that Petra, once born, would begin to search for Nicole… backward. For to the Codex of the Architects of the Code, time was but a fragile stage set, a convenient illusion. Messages could travel in either direction.

The memory of adolescence resurfaced, sharp as a scalpel: the hi-fi switching on by itself to Mozart, the radio frozen at 97.1, the blurred whisper *"…waiting for you…"*, the strange symbols on the television screen.

And what if that voice, from a future Nicole would never know, had not been a warning… but a call?

Author's Notes

Waves have accompanied me throughout my scientific journey. I have encountered them in many forms: in water shaping waves, in air carrying sound and ultrasound, in light unfolding into colorful spectra, and even in the cosmic void, where electromagnetic and plasma waves travel… In the hospital too, when my son was followed in audiology for five years.

I have sought to understand them at every scale. In astrophysics, they reveal the dynamics of stars and the universe, from stellar vibrations to gravitational waves. In biology, DNA itself can be thought of as a wave: a vibratory architecture, made of frequencies and resonances. This continuity between life and the cosmos has always fascinated me.

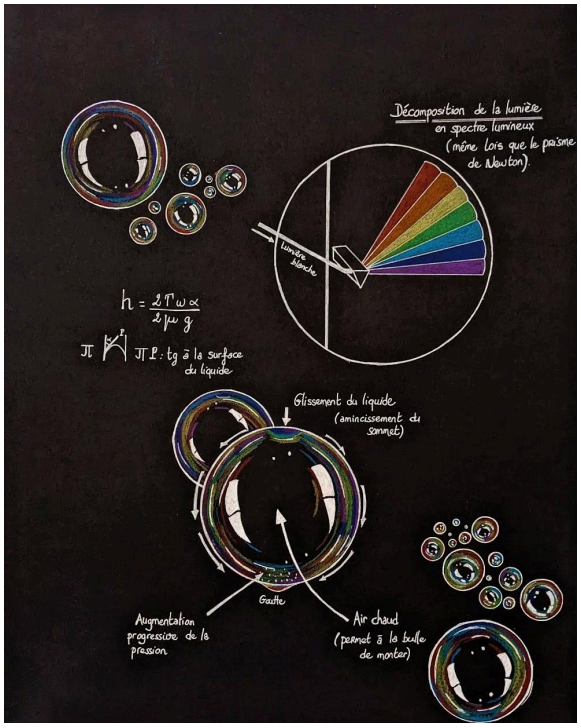
A seemingly ordinary object became my miniature laboratory: the soap bubble. I explored its physics by studying some thirty ancient and modern works, and then by redoing the experiments myself. I discovered a world of light interferences, minimal surfaces, frozen bubbles that crystallize, and almost infinite wave-like patterns.

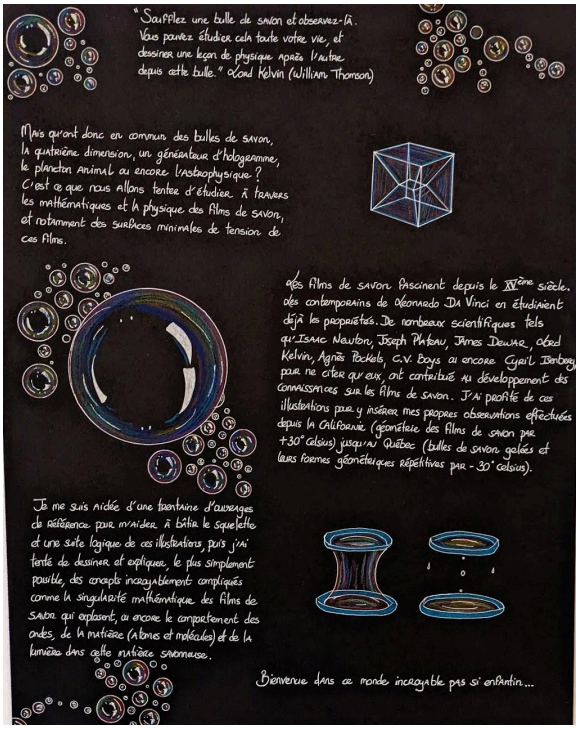
These plates, created for my *Children's Books Science* project in collaboration with the Yale Peabody Museum of Natural History, show how fragile phenomena conceal a mathematical and physical beauty—and how they can inspire wonder in both children and adults.

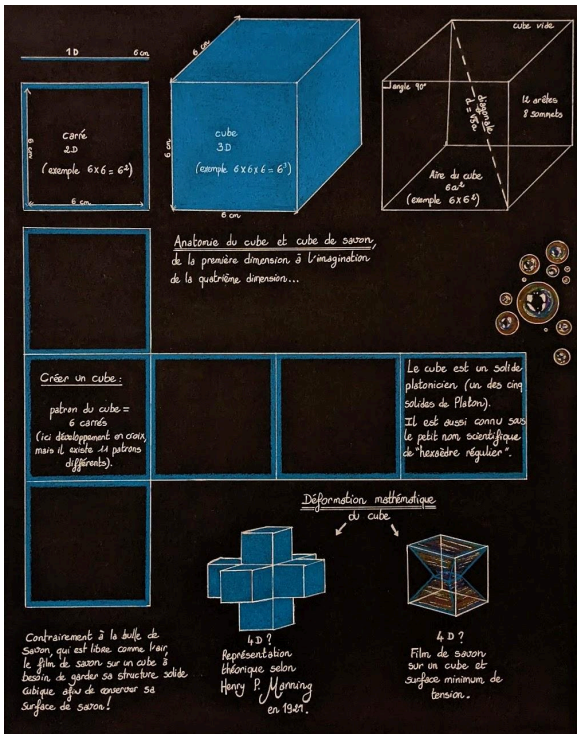
From this approach was born my short story *The Architects of the Code.* As with my research on bubbles, I began with concrete objects and followed them down to their scientific foundations, pushing my reasoning without fear of reaching strange, sometimes unsettling results—as in *The Codex 97.1.128.* For behind every wave lies a structure, a language, a memory. From DNA to galaxies, from soap bubbles to starlight, everything seems to vibrate under a single universal principle.

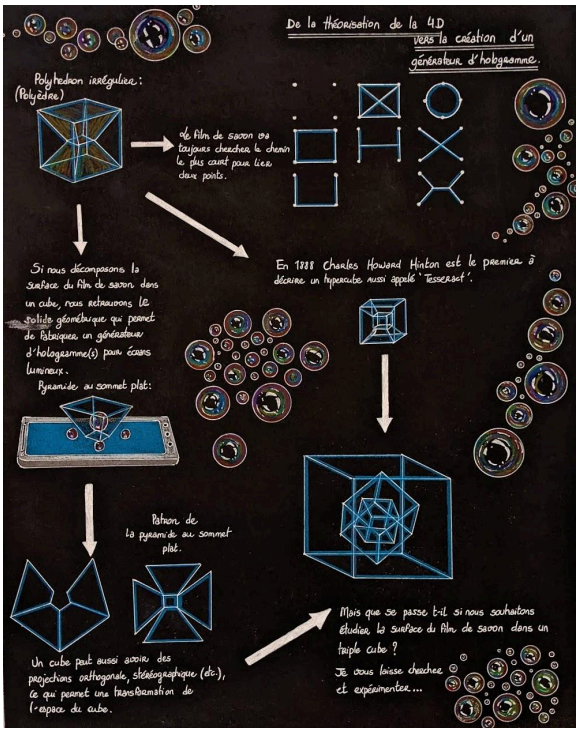
I have always practiced science independently, sometimes at the margins of institutions, with a curiosity free of boundaries. This is what I call the anarchist side of science: to repeat forgotten gestures, to experiment firsthand, to verify instead of believing, to move forward without waiting for academic approval. Bubbles have taught me that research can be both rigorous and playful, serious and free. Their fragility hides an implacable logic—the same that governs living matter and the stars.

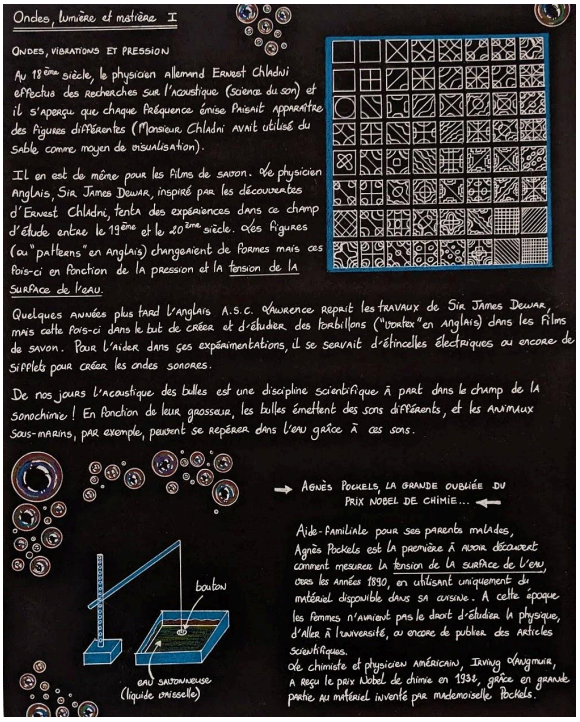
It is this freedom of spirit, this desire to see for myself, that nourishes *The Architects of the Code.* I defend a simple idea: science does not belong only to laboratories. It can be born anywhere—in a living room, a garden, or in front of a soap bubble. Knowledge is not a privilege; it is an experience to be shared.

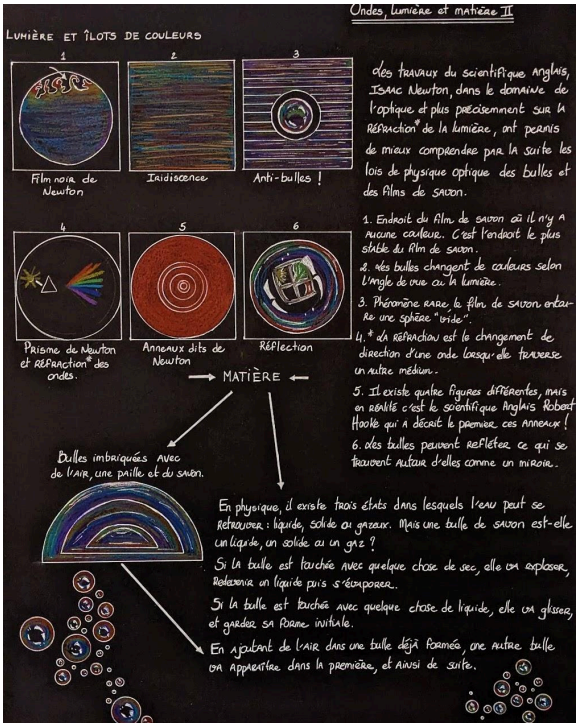

Décomposition de la lumière
en spectre lumineux
(même lois que le paisme de Newton).
lumière blanche
$h = \frac{2\Gamma\omega\alpha}{2\mu g}$
Γ : tg à la surface du liquide
Glissement du liquide (amincissement du sommet)
Goutte
Augmentation progressive de la pression
Air chaud (permet à la bulle de monter)

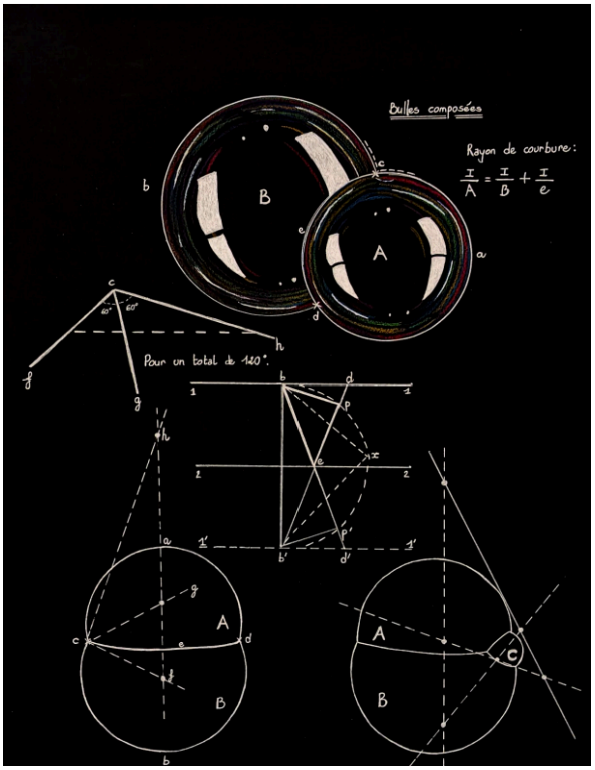

"Soufflez une bulle de savon et observez-la. Vous pourrez étudier cela toute votre vie, et dessiner une leçon de physique après l'autre depuis cette bulle." Lord Kelvin (William Thomson)
Mais qu'ont donc en commun des bulles de savon, la quatrième dimension, un générateur d'hologramme, le plancton animal ou encore l'astrophysique ? C'est ce que nous allons tenter d'étudier à travers les mathématiques et la physique des films de savon, et notamment des surfaces minimales de tension de ces films.
Des films de savon fascinent depuis le XVIème siècle. Des contemporains de Léonardo Da Vinci en étudiaient déjà les propriétés. De nombreux scientifiques tels qu'Isaac Newton, Joseph Plateau, James Dewar, Lord Kelvin, Agnès Pockels, C.V. Boys ou encore Cyril Isenberg pour ne citer qu'eux, ont contribué au développement des connaissances sur les films de savon. J'ai profité de ces illustrations pour y insérer mes propres observations effectuées depuis la Californie (géométrie des films de savon par +30° Celsius) jusqu'au Québec (bulles de savon gelées et leurs formes géométriques répétitives par - 30° Celsius).
Je me suis aidée d'une trentaine d'ouvrages de référence pour m'aider à bâtir le squelette et une suite logique de ces illustrations, puis j'ai tenté de dessiner et expliquer, le plus simplement possible, des concepts incroyablement compliqués comme la singularité mathématique des films de savon qui explosent, ou encore le comportement des ondes, de la matière (atomes et molécules) et de la lumière dans cette matière savonneuse.
Bienvenue dans ce monde incroyable pas si enfantin...


1D
6 cm
carré
2D
(exemple 6x6 = 6²)
cube
3D
(exemple 6x6x6 = 6³)
cube vide
angle 90°
diagonale d = 8,5 cm
12 arêtes
8 sommets
Aire du cube
6a²
(exemple 6x6²)
Anatomie du cube et cube de savon, de la première dimension à l'imagination de la quatrième dimension...
Créer un cube :
patron du cube =
6 carrés
(ici développement en croix, mais il existe 11 patrons différents).
Le cube est un solide platonicien (un des cinq solides de Platon).
Il est aussi connu sous le petit nom scientifique de "hexaèdre régulier".
Déformation mathématique du cube
Contrairement à la bulle de savon, qui est libre comme l'air, le film de savon sur un cube à besoin de garder sa structure solide cubique afin de conserver sa surface de savon !
4D ?
Représentation théorique selon Henry P. Manning en 1921.
4D ?
Film de savon sur un cube et surface minimum de tension.


De la théorisation de la 4D vers la création d'un générateur d'hologramme.
Polyhedron irrégulier : (Polyèdre)
Le film de savon va toujours chercher le chemin le plus court pour lier deux points.
Si nous décomposons la surface du film de savon dans un cube, nous retrouvons le solide géométrique qui permet de fabriquer un générateur d'hologramme(s) pour écrans lumineux.
Pyramide au sommet plat :
En 1888 Charles Howard Hinton est le premier à décrire un hypercube aussi appelé 'Tesseract'.
Patron de la pyramide au sommet plat.
Un cube peut aussi avoir des projections orthogonale, stéréographique (etc.), ce qui permet une transformation de l'espace du cube.
Mais que se passe-t-il si nous souhaitons étudier la surface du film de savon dans un triple cube ?
Je vous laisse chercher et expérimenter...


Ondes, lumière et matière I
ONDES, VIBRATIONS ET PRESSION
Au 18ème siècle, le physicien allemand Ernest Chladni effectua des recherches sur l'acoustique (science du son) et il s'aperçu que chaque fréquence émise faisait apparaître des figures différentes (Monsieur Chladni avait utilisé du sable comme moyen de visualisation).
Il en est de même pour les films de savon. Le physicien Anglais, Sir James Dewar, inspiré par les découvertes d'Ernest Chladni, tenta des expériences dans ce champ d'étude entre le 19ème et le 20ème siècle. Les figures (ou "patterns" en Anglais) changeaient de formes mais ces fois-ci en fonction de la pression et la tension de la surface de l'eau.
Quelques années plus tard l'anglais A.S.C. Laurence reprit les travaux de Sir James Dewar, mais cette fois-ci dans le but de créer et d'étudier des tourbillons ("vortex" en Anglais) dans les films de savon. Pour l'aider dans ses expérimentations, il se servait d'étincelles électriques ou encore de sifflets pour créer les ondes sonores.
De nos jours l'acoustique des bulles est une discipline scientifique à part dans le champ de la sonochimie ! En fonction de leur grosseur, les bulles émettent des sons différents, et les animaux sous-marins, par exemple, peuvent se repérer dans l'eau grâce à ces sons.
bouton
eau savonneuse (liquide vaisselle)
→ AGNÈS POCKELS, LA GRANDE OUBLIÉE DU PRIX NOBEL DE CHIMIE... ←
Aide-familiale pour ses parents malades, Agnès Pockels est la première à avoir découvert comment mesurer la tension de la surface de l'eau, dans les années 1890, en utilisant uniquement du matériel disponible dans sa cuisine. A cette époque les femmes n'avaient pas le droit d'étudier la physique, d'aller à l'université, ou encore de publier des articles scientifiques.
Ce chimiste et physicien américain, Irving Langmuir, a reçu le prix Nobel de chimie en 1932, grâce en grande partie au matériel inventé par mademoiselle Pockels.


Ondes, lumière et matière II
LUMIÈRE ET ÎLOTS DE COULEURS
1
2
3
Film noir de Newton
Iridiscence
Anti-bulles !
4
5
6
Prisme de Newton et réfraction des ondes.
Anneaux dits de Newton
Réflection
→ MATIÈRE ←
Bulles imbriquées avec de l'air, une paille et du savon.
des travaux du scientifique Anglais, Isaac Newton, dans le domaine de l'optique et plus précisément sur la réfraction* de la lumière, ont permis de mieux comprendre par la suite les lois de physique optique des bulles et des films de savon.
1. Endroit du film de savon où il n'y a aucune couleur. C'est l'endroit le plus stable du film de savon.
2. Les bulles changent de couleurs selon l'angle de vue ou la lumière.
3. Phénomène rare, le film de savon entoure une sphère "vide".
4.* La réfraction est le changement de direction d'une onde lorsqu'elle traverse un autre médium.
5. Il existe quatre figures différentes, mais en réalité c'est le scientifique Anglais Robert Hooke qui a décrit le premier ces anneaux !
6. Les bulles peuvent refléter ce qui se trouvent autour d'elles comme un miroir.
En physique, il existe trois états dans lesquels l'eau peut se retrouver : liquide, solide ou gazeux. Mais une bulle de savon est-elle un liquide, un solide ou un gaz ?
Si la bulle est touchée avec quelque chose de sec, elle va exploser, redevenir un liquide puis s'évaporer.
Si la bulle est touchée avec quelque chose de liquide, elle va glisser, et garder sa forme initiale.
En ajoutant de l'air dans une bulle déjà formée, une autre bulle va apparaître dans la première, et ainsi de suite.


Bulles composées
Rayon de courbure:
$\frac{1}{A} = \frac{1}{B} + \frac{1}{e}$
Pour un total de 120°.

About the Author

Victoria Kayser-Cuny, a dual citizen of Canada and France, is trained in molecular genetics, with advanced specializations in paleogenetics, exobiology, bioarchaeology, evolutionary genetics, particle physics, astronomy/astrophysics, biochemistry, and intellectual property. Her academic path has taken her across France, Switzerland, Canada, and the United States.

She has also taught STEM disciplines (science, technology, engineering, and mathematics) and, since 2022, has been writing a newsletter on G.R.AI.N. — Genetics, Robotics, Artificial Intelligence, and Nanotechnology on LinkedIn.

She is a Fellow of the Linnean Society of London (whose members once included Charles Darwin), a Fellow of the Royal Anthropological Institute of Great Britain and Ireland, a Full Member of the Genetics Society of London, and a student member of the Royal Society of Chemistry.

A passionate practitioner of bookbinding and codicology, she has published several articles in French, including *“The Future of Codicology: From 13th-Century Chemists to DNA Fragment Data Storage”* (2024, Quebec). A collector of mathematics and physics books, she was also, like Michael Faraday before her, once a bookbinding apprentice.

Her interest in hard science fiction writing was born during a doctoral seminar at the Institut Pasteur, entitled *“Introduction to the Relations Between Science and Society”*, where the works of Ursula K. Le Guin were particularly emphasized.

Petra is her third given name, and Ai Rotciv is simply “Victoria” written backwards.

Artificial Intelligence in this Story

Victoria Kayser-Cuny published her first short story in 1999 in a French technology journal (*Le Monde Informatique*), already exploring speculative themes long before AI became a writing tool for many. She continues to build her narratives independently, while occasionally using tools such as ChatGPT for light proofreading—just as one might ask a colleague to review a manuscript. The ideas, structure, and writing remain entirely her own.

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